

Climate and Severe Weather Workshop

March 11-12, 2015

NCWCP College Park, MD



MAPP
Modeling, Analysis,
Predictions, and Projections



Weather-Ready Nation

National Oceanic and Atmospheric Administration

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Spring Has Sprung! Get Ready for Some of America's Wildest Weather

Date Posted: March 1, 2015

Spring Has Sprung! Get Ready for Some of America's Wildest Weather



Tornadoes, floods, thunderstorm winds, hail, lightning, heat, wildfires, rip currents and tsunamis - spring is three months of danger that can imperil the unprepared. It roars in like a lion and continues to roar across the United States throughout March, April and May.

Outreach Toolkit

Help us get the word out about spring hazards! Use our social media plans and other content to encourage spring hazard preparedness.

Recent History

- April 2011 severe weather outbreaks had devastating impacts.
- Whitehouse asked NOAA if there is a seasonal tornado outlook. That's a tall order!
- Weather/Climate scientists began to talk about it via telecons.
- First workshop sponsored by SPC/NSSL/CPC in Norman Oklahoma, May 2012.
- White Paper & NOAA Fact Sheet was developed out of this effort. NOAA/CPO/MAPP & others support research projects.
- Another workshop was held at IRI/Columbia University in March 2013.
- September 2014 Obama Executive Order calls for weeks 3-4 extreme weather risk outlooks.
- NWS/NCEP incorporates a deliverable in AOP to assess the feasibility of developing extended and long range severe weather outlooks.
- So here we are.

White Paper – Fact Sheet – New Synopsis

Advancing the Nation's capability to anticipate tornado and severe weather risk

Scott Weaver (NOAA/CPC), Jeff Trapp (Purdue University), Michael K. Tippett (IRI), Russell Schneider (NOAA/SPC), Phil Pegion (NOAA/ESRL/CIRES), Sang-Ki Lee (NOAA/AOML), Wayne Higgins (NOAA/CPC), Andy Dean (NOAA/SPC), Greg Carbin (NOAA/SPC), Harold Brooks (NOAA/NSSL), Mike Baldwin (Purdue University), Francisco Alvarez (Saint Louis

forecast models; their ongoing work similarly demonstrates the viability of using global climate models, including the CFS, in such a dynamical downscaling approach. The forecast model – Weather Research and Forecasting (WRF) model – is configured such that convective clouds and storms are explicitly represented over the entire domain. The output of such convection-permitting WRF-model integrations over months and seasons is then mined to determine the spatial distribution and frequency of convective storms by type and severity. Figure 3 shows an example of a predicted severe storm occurrence over the period April through June of 2012, generated by WRF-enabled downscaling of the CFS model.

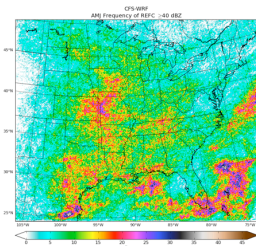


Fig. 3. Example of predicted storm occurrence (simulated radar reflectivity > 40 dBZ) over the period April, May, Jun, 2012, generated by WRF-enabled downscaling of the CFS model.

Observational Databases

Underpinning our current understanding of the severe weather environment and its climate connections is a long term (1950-present) historical database of F-scale tornado counts. Since this database was not intended to be a consistent homogenous long-term climate record of tornadic and severe weather parameters, there are inherent inconsistencies as a result of public awareness, tornado reporting practices, NWS guidelines, and other sources of inhomogeneity. These issues may introduce spurious trends in the long-term tornado data. However, it has been demonstrated that much of this trend can be ameliorated by focusing on the F1-F5 tornado counts only (Verbout et al. 2006) as demonstrated in Figure 4 which shows that much of the trend can be explained through the timeseries evolution of the F0 tornado counts. Nevertheless, it is necessary to explore other novel ways to further homogenize the long-term historical tornado database while simultaneously taking

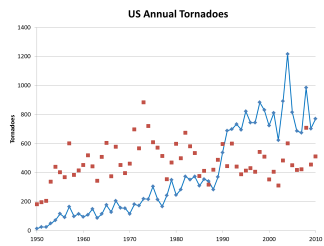


Fig. 4. Time series of F0 (blue) and F1 and greater (red) annual tornado counts for 1950-2010.

State of the Science FACT SHEET

Tornadoes, Climate Variability, and Climate Change

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION • UNITED STATES DEPARTMENT OF COMMERCE

This assessment of tornado activity and climate was developed by scientists and communication experts from the National Oceanic and Atmospheric Administration (NOAA).

Tornadoes are intense rotating vertical columns of air that pose a great threat to lives and property. They typically form in an environment where winds are rapidly changing direction and speed with height (commonly referred to as wind shear) and the atmosphere is convectively unstable. Tornado strength is classified according to the Fujita (F) Scale F0-F5, with F0 being the weakest and F5 the strongest. Tornado activity refers to the number and intensity of tornadoes over a given region, season, or year. While tornadoes can occur during any season in the U.S., they are most likely during the spring months of March, April, and May.

Given the right set of atmospheric conditions, tornadoes can occur almost anywhere. However, the areas of the U.S. most susceptible include the Great Plains, Midwest and South. The configuration of the topography of the North American continent (Rocky Mountains, Great Plains, and proximity to the Gulf of Mexico) contributes to the development of large-scale weather systems capable of supporting severe thunderstorms and related tornado events.

Are the frequency and/or intensity of tornadoes increasing?

Underpinning our current understanding of tornado activity is a long-term (1954-present) record of historical tornado counts from NOAA's Severe Weather Database (SWD). Given that the SWD was not intended to be a consistent homogenous long-term climate record of tornadoes, there are inconsistencies over time as a result of changes in public awareness, tornado reporting practices, Doppler radar technology, and National Weather Service (NWS) guidelines, to name a few.

These inconsistencies have likely introduced artificial trends in the long-term tornado data making attribution of long-term changes in tornado frequency/intensity difficult to determine. This issue is highlighted by a comparison of all tornado counts (F0-F5) with only the F1-F5 tornadoes (Figure 1). Removing the F0 counts from the database nearly eliminates the trend. Despite the potential for spurious trends in the SWD, this does not rule out the possibility that a portion of the trend is due to climate change or natural climate variability.

What is the role of natural climate variability in tornadic activity?

Emerging evidence suggests that natural climate variations such as El Niño and La Niña events and in particular the transition from one to another in spring, have the potential to modulate the environmental factors

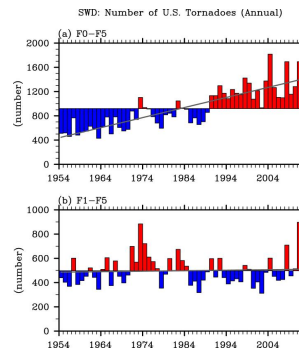


Figure 1. The number of F0-F5 (upper), F1-F5 (lower) annual tornado counts for 1954-2011 from the NOAA Severe Weather Database. The gray lines show the linear trend for the respective F-scale intervals. (From Lee et al. 2012)

conducive to tornado formation¹. Natural variations acting on decadal timescales (e.g., Atlantic Multidecadal and Pacific Decadal Oscillations) have also been similarly implicated. However, uncertainty is higher because these phenomena are influential over the course of roughly 30 years and the tornado record is only approximately 60 years long. The link between these inter-annual-to-decadal natural climate variability modes and variations in tornado activity is typically via shifts in the large scale upper and lower level jet streams across North America that act as focusing mechanisms for severe thunderstorm development. Shifts in the placement and strength of these jet streams will influence the locations of

*A new Enhanced Fujita scale was adopted in 2007.

April 2013

NOAA.gov

Climate and Hazardous Convective Weather

Michael K. Tippett · John T. Allen ·
Vittorio A. Gensini · Harold E. Brooks

Curr Clim Change Rep

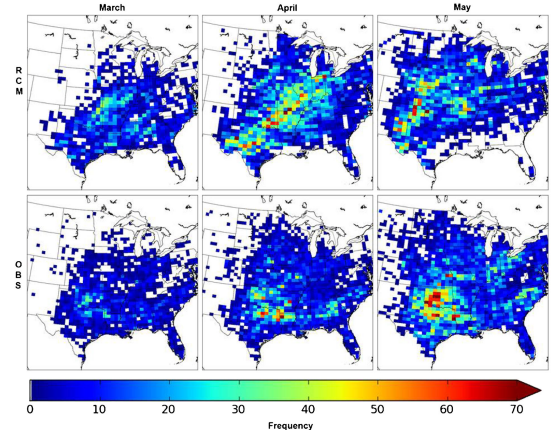


Fig. 4 Frequency of 1980-1990 March-May HWC as depicted synthetically from a RCM using dynamical downscaling (top row) and observations (bottom row). Used with permission from [45]

ENSO

ENSO modulates US precipitation and temperature via perturbations of the jet stream [75, 76]. In winter months, El Niño conditions enhance the jet stream over the Gulf Coast,



Fig. 5 Anomaly of a central US tornado day between 90 and 106 W by MJO phase for the period 1990-2011 [6]

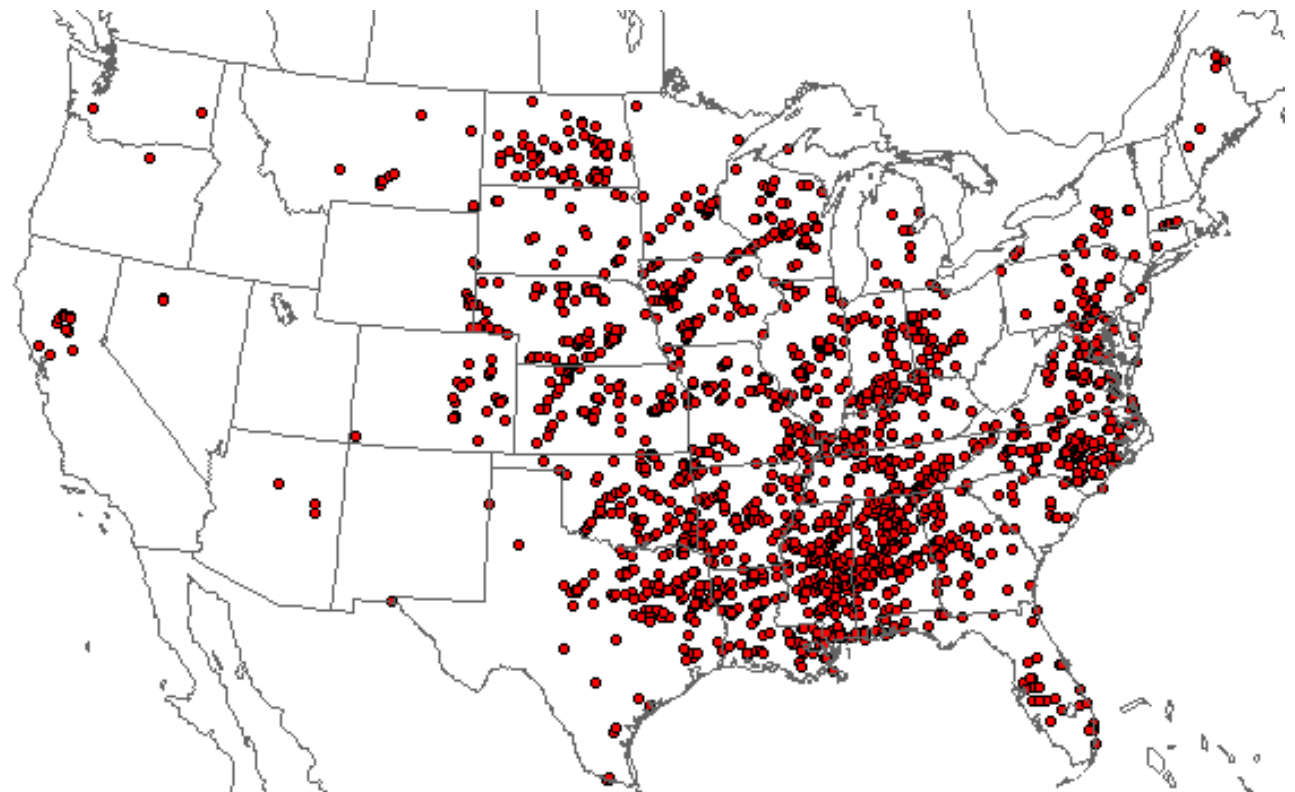
increasing regional tornado frequency and suppressing it over the continent. In contrast, a northwardly displaced jet during La Niña conditions increases the likelihood of tornado occurrence further north, along a band extending from Louisiana to Michigan [25, 64]. A relationship between La Niña conditions and enhanced HWC has proven difficult to demonstrate robustly for the spring season [25, 64]. While limitations of the observational record and high variability have made it difficult to demonstrate an unambiguous relation between ENSO and springtime US HWC activity, several lines of evidence are highly suggestive of enhanced HWC activity occurring during La Niña conditions. Muñoz and Enfield [67] found a rank correlation of -0.41 between the Niño 3.4 index and an index of spring (E)F2+ tornado numbers in the region of the lower Mississippi, Tennessee and Ohio River basins for the period 1950-2006. However, this regional tornado activity index has long-term trends similar to the US annual one in Fig. 1. Weaver et al. [96] correlated global SST with regional (E)F2+ and detrended (E)F0+ April-June values over the period 1950-2010. Negative SST correlations over much of the globe were found with the North Great Plains (E)F2+ index. Using April and

2011 Tornadoes

6 “Events”

\$27.7 Billion

539 Fatalities



PRELIMINARY SEVERE WEATHER
REPORT DATABASE (ROUGH LOG)

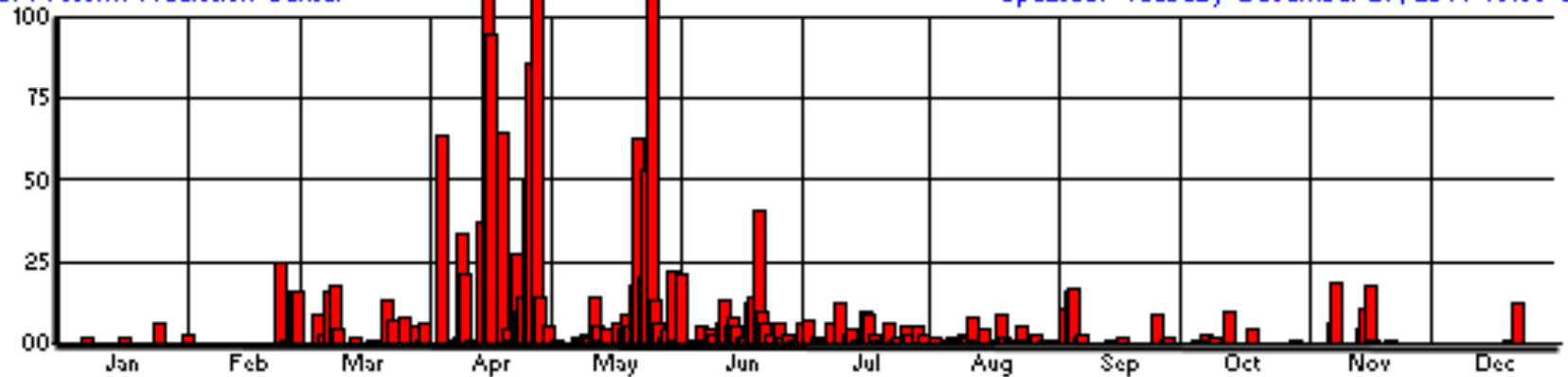
NOAA/Storm Prediction Center Norman, Oklahoma

Tornado Reports
January 01, 2011 - December 27, 2011

Updated: Tuesday December 27, 2011 16:35 CT

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Tornado Reports

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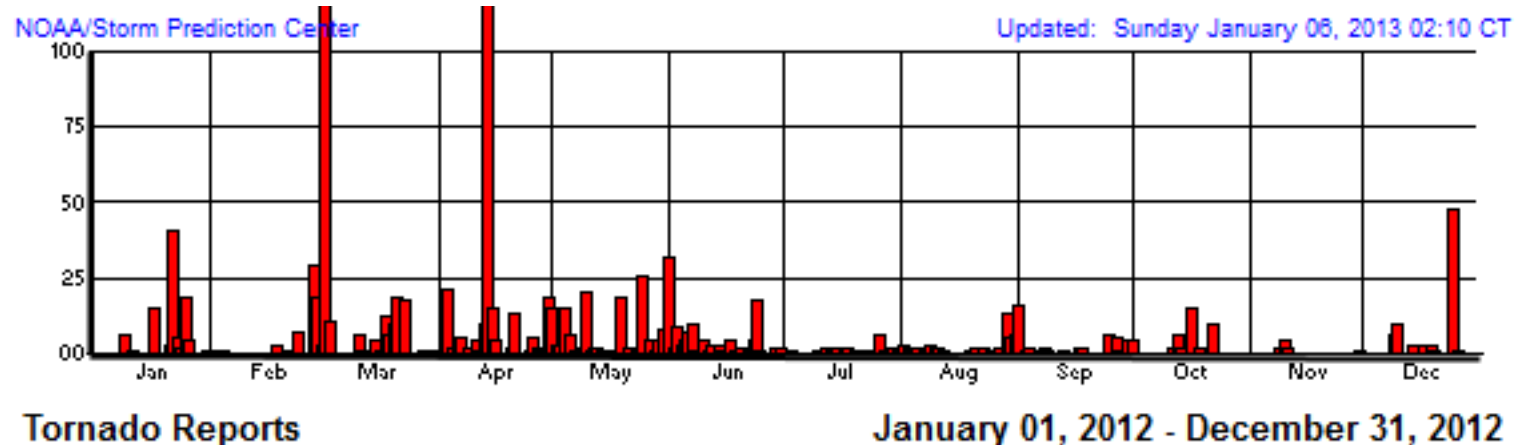
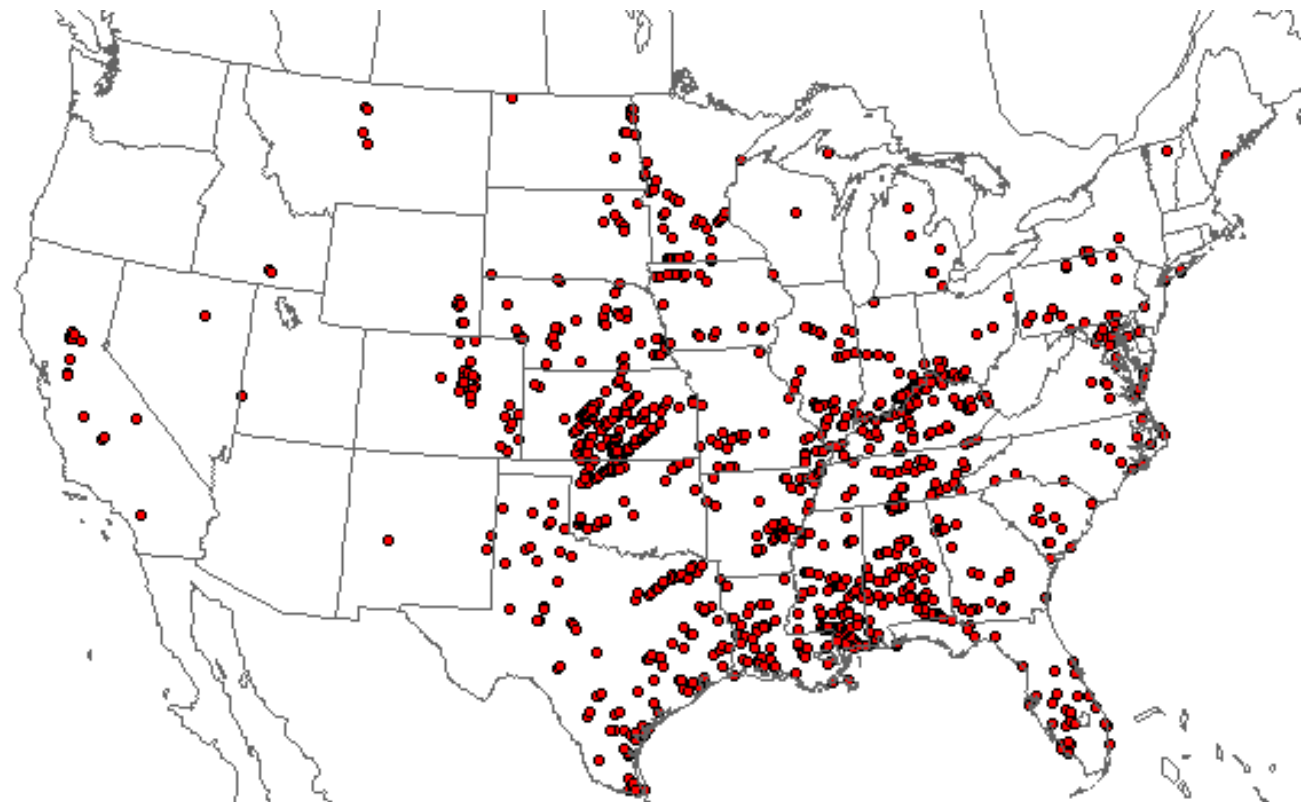
2012 Tornadoes

Lowest Since 1989

3 “Events”

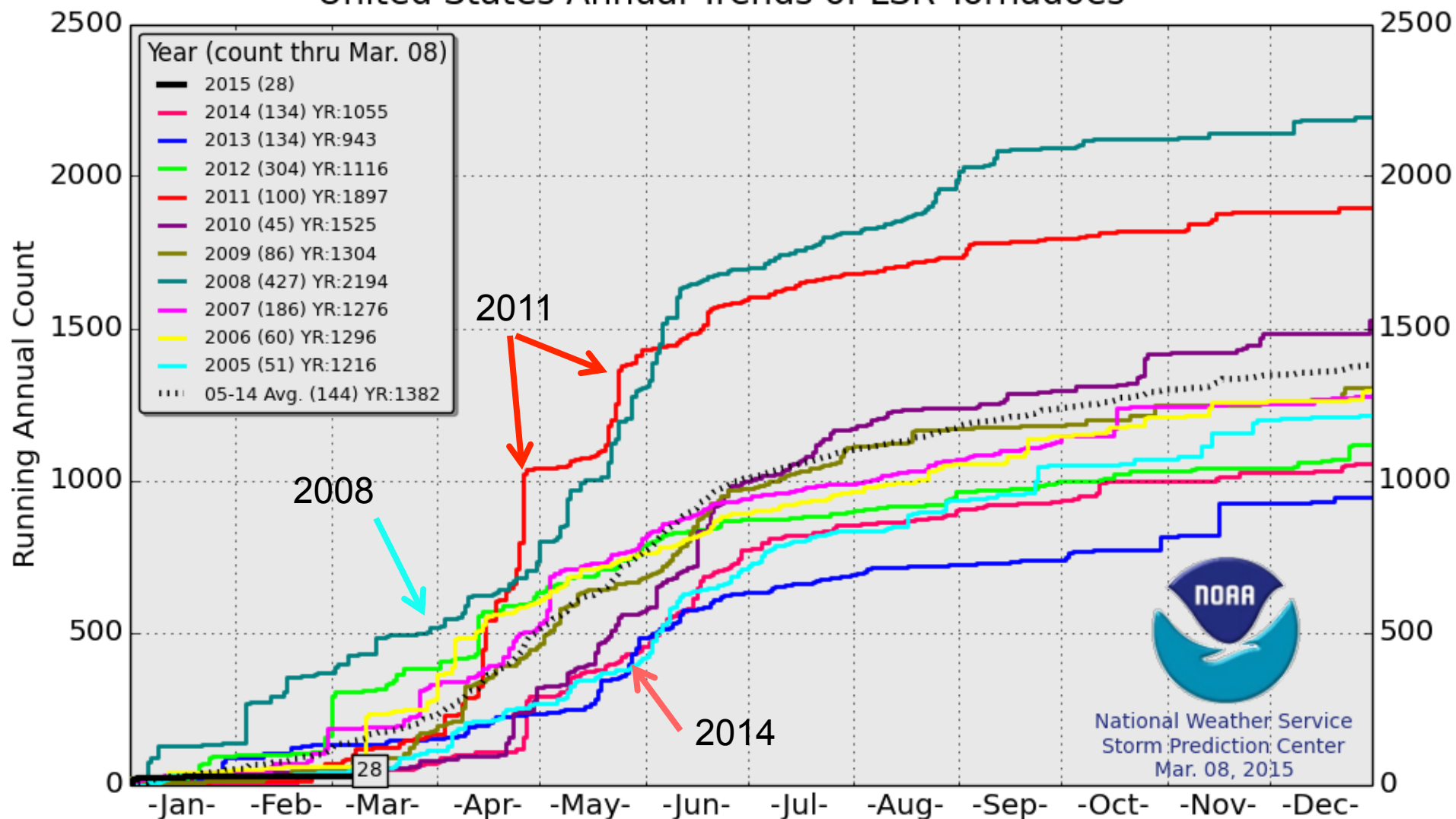
At least \$3 Billion

68 Fatalities



Tornadoes 2005-15

United States Annual Trends of LSR Tornadoes*

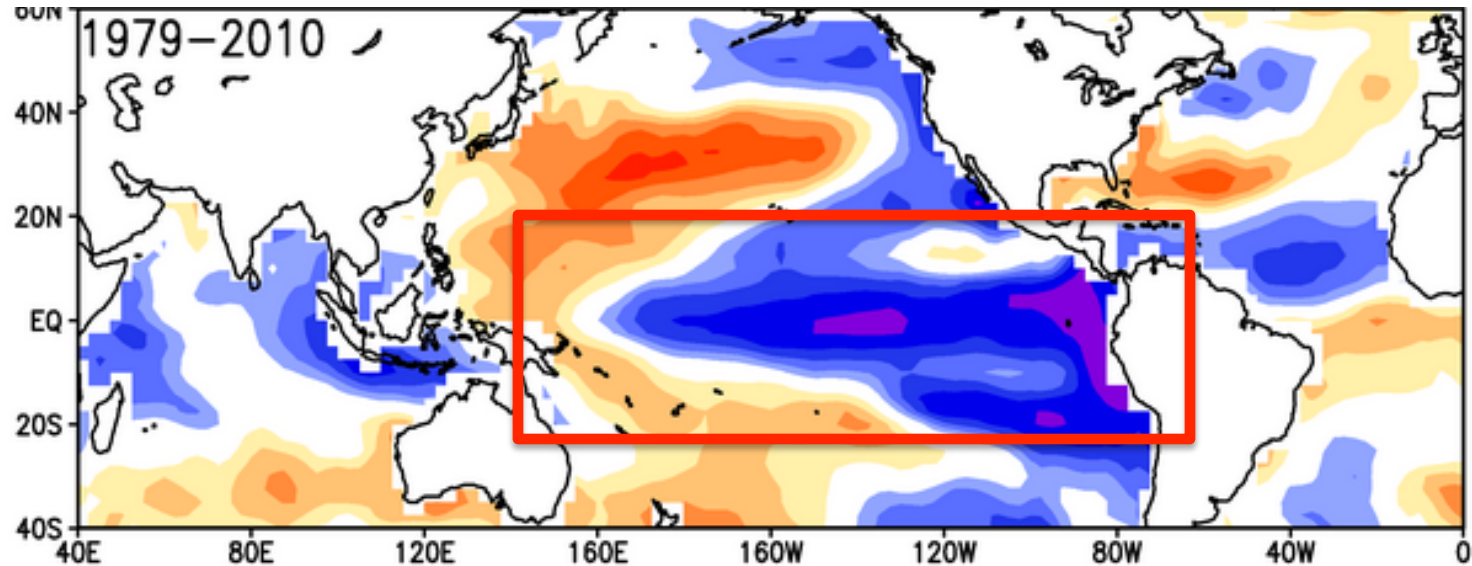


*Preliminary sightings/events from NWS Local Storm Reports (LSRs)
Annual average is based on preliminary LSRs 2005-2014

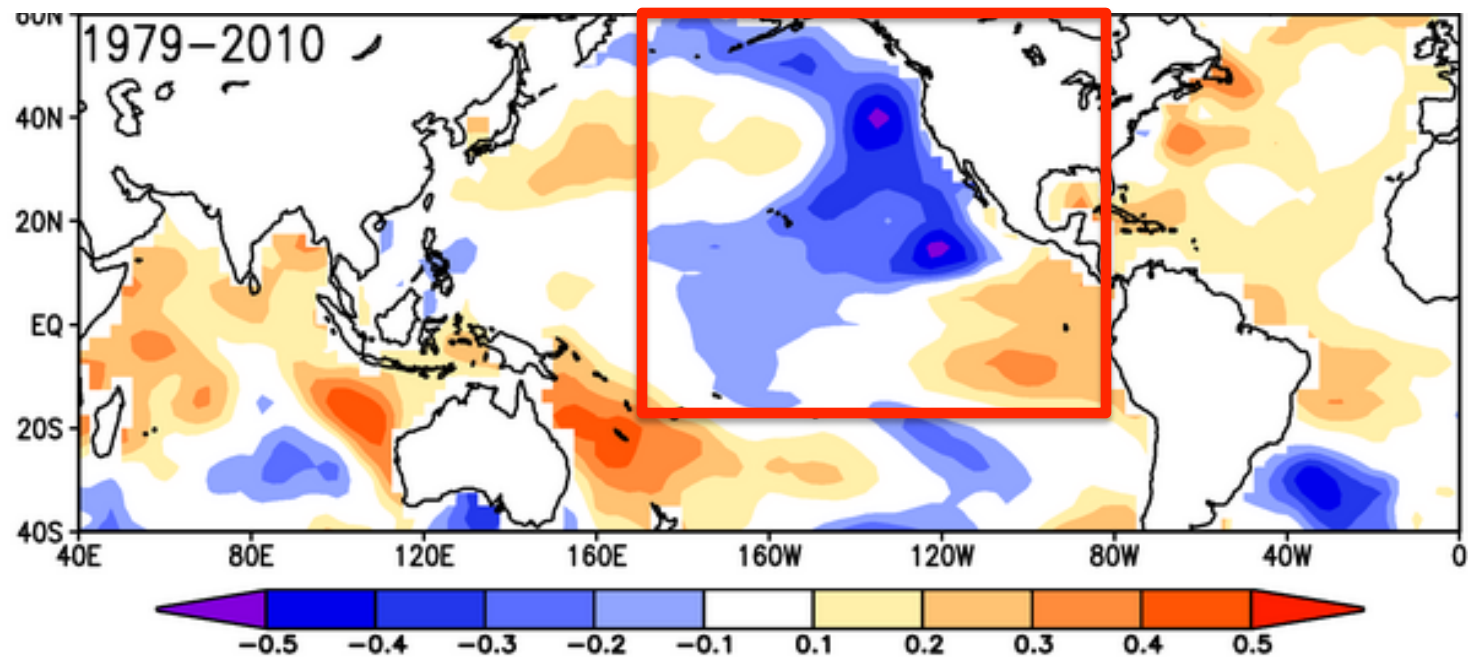
*The time to repair the roof is when the sun
is shining ~ J.F.K.*

Why Do We Think Extended and Long Range Severe Weather Outlooks May be Possible

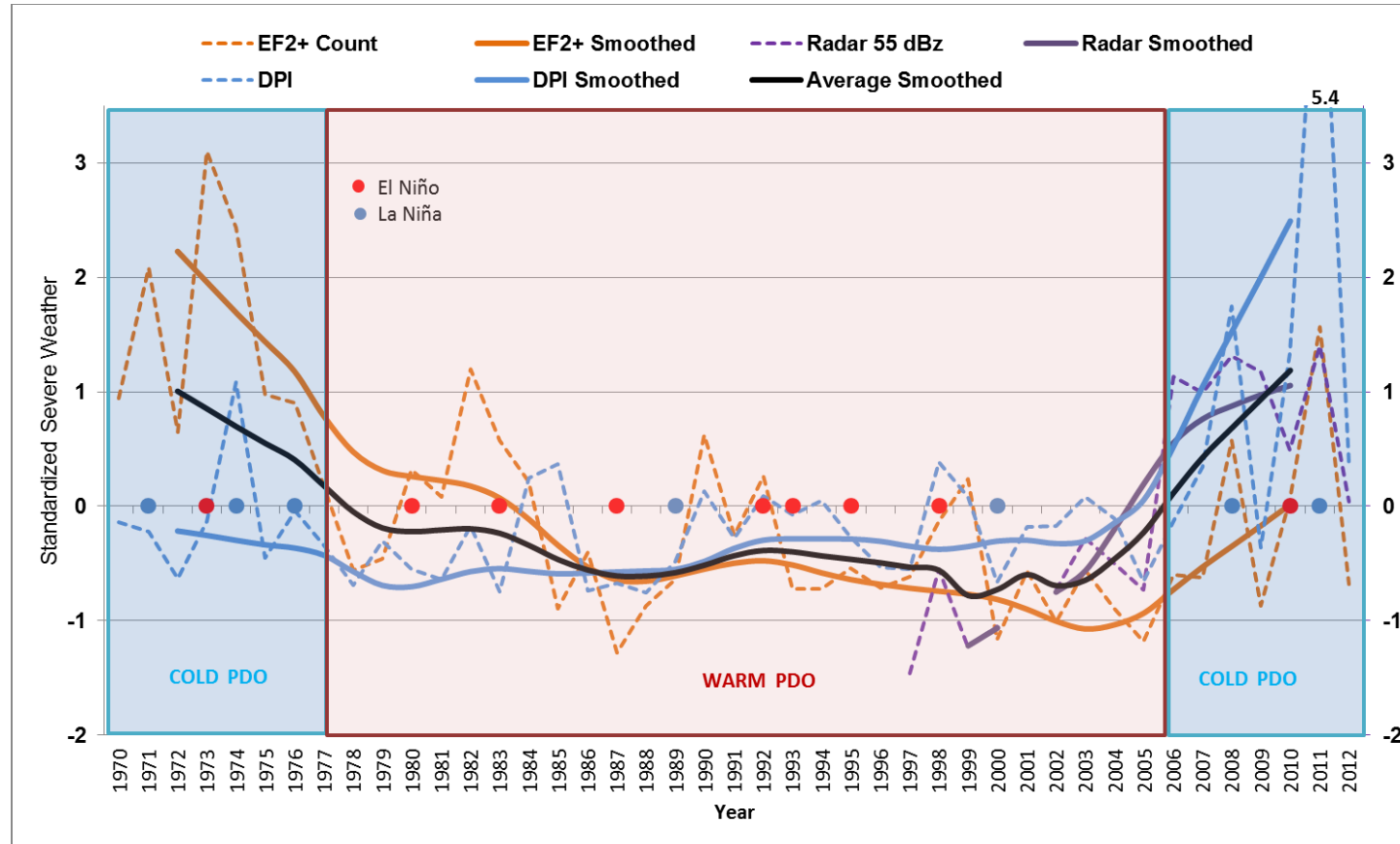
AMJ NGP Tornado Days



AMJ SE Tornado Counts F3-F5



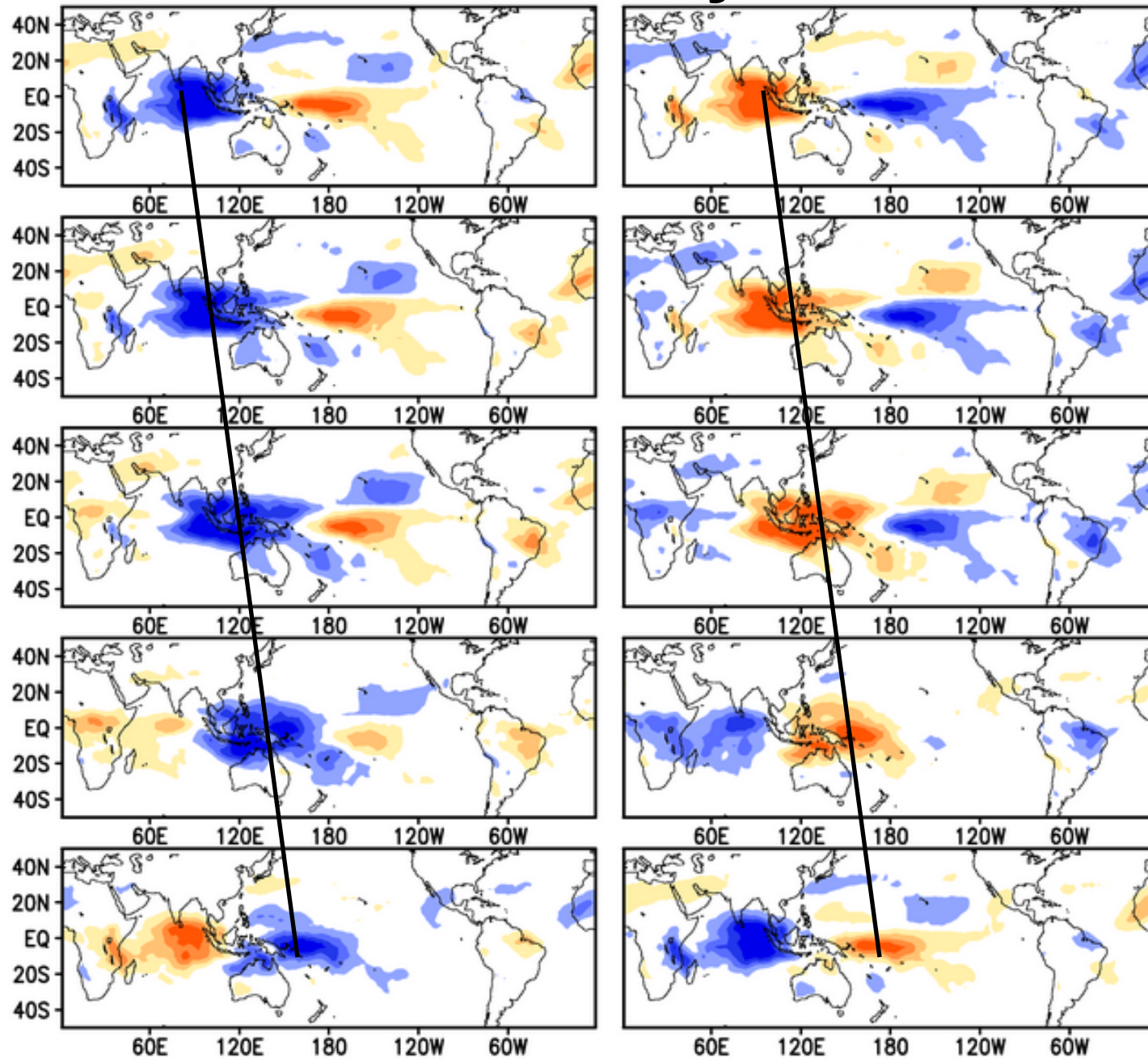
2013 U.S. Severe Thunderstorm Outlook



- Severe convective storm activity is increasing and is likely tied to a multidecadal climate pattern shift.
- Correlation of the PDO index with EF2+ counts is as high as -0.50 for Jan-Jun.
- Twice as likely to have major tornado outbreak during cold PDO vs. Warm PDO since 1970.
- Interannual variation in indices tied to La Nina and its influence on upper level jet shifting.

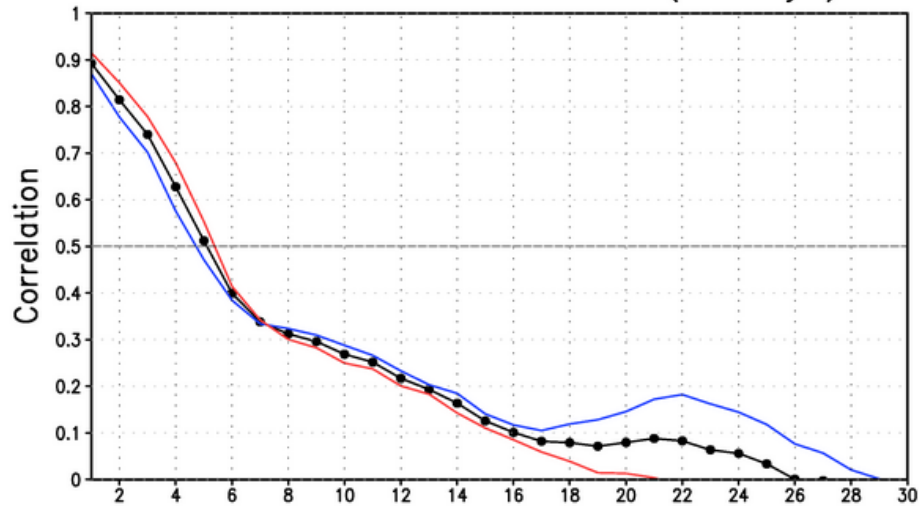
Intraseasonal

MJO Lifecycle

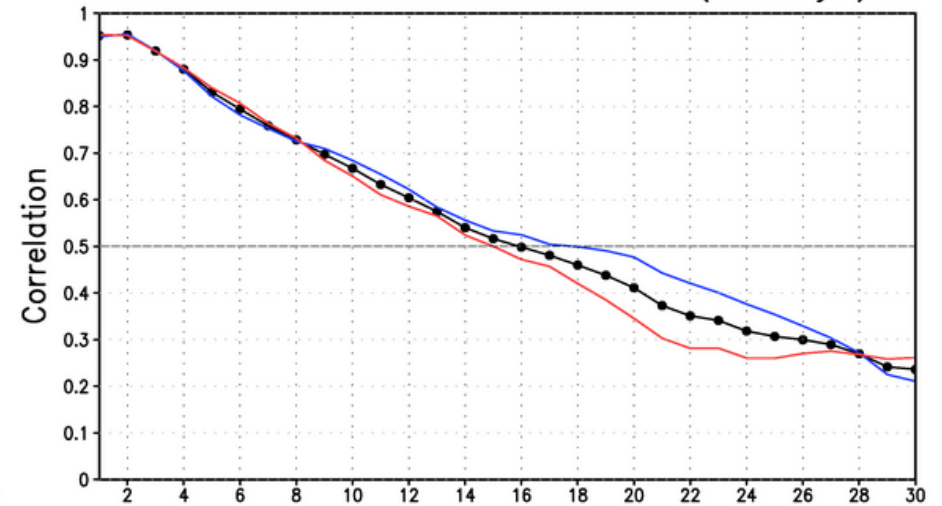


CFSv1 & CFSv2 PC1 & PC2

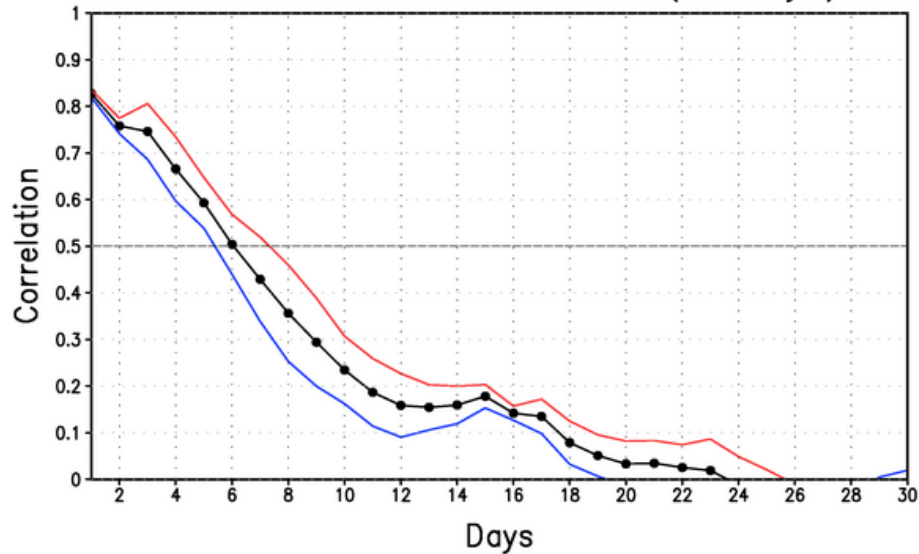
CFSV1 CHI200 PC1 vs R2 (all days)



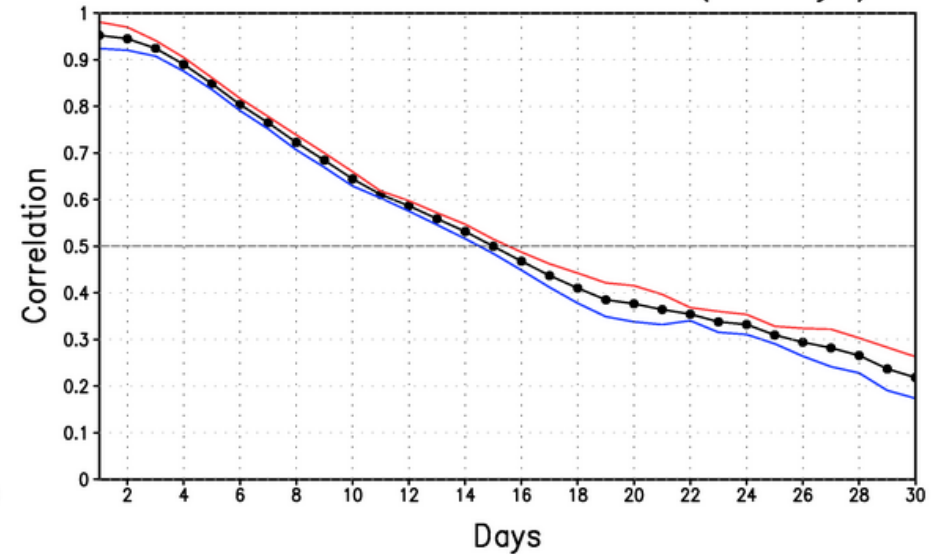
CFSV2 CHI200 PC1 vs CFSR (all days)



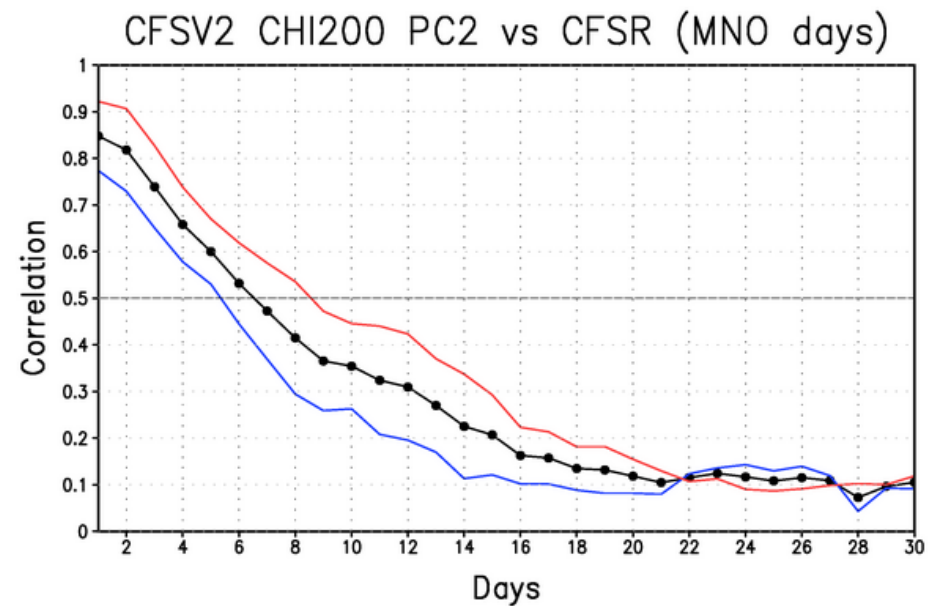
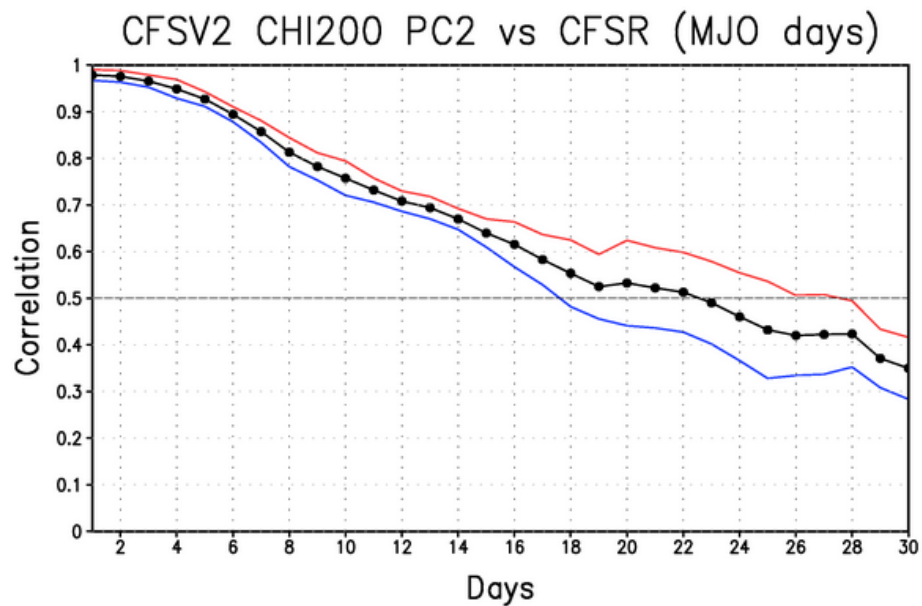
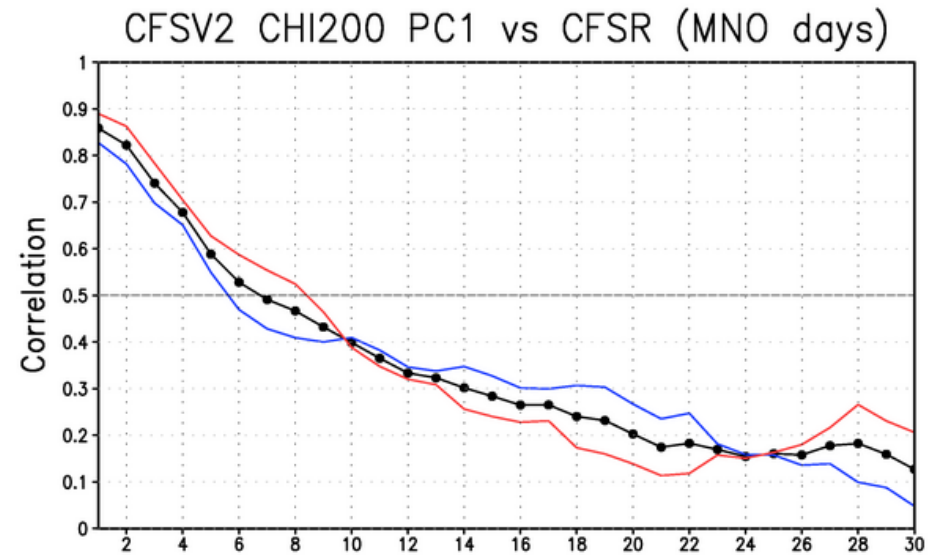
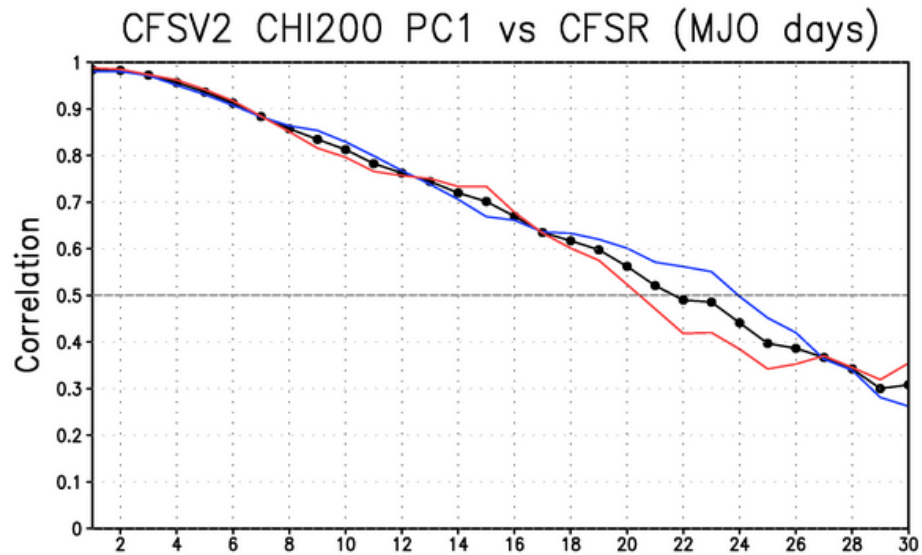
CFSV1 CHI200 PC2 vs R2 (all days)



CFSV2 CHI200 PC2 vs CFSR (all days)



CFSv2 MJO & MJNO PC1 & PC2



Workshop Goals

- Science Updates
 - Latest research on severe weather climatology from reanalysis and observational records.
 - Updates on medium-range to seasonal-range severe weather prediction methods.
- Toward developing long range prediction products.
 - Research Targets
 - Forecast Targets
 - Verification
- Discussion regarding the potential role of NCEP centers and partners with respect to future severe weather prediction products.
- Developing a strategy to inform NOAA climate and weather interests and the greater community of our efforts.

Day 1 Agenda

Session 1	Welcome, Programs, and Current Practices	
8:40 am	Room Open/Setup	
9:00 am	Welcome and Overview	Scott Weaver
9:20 am	Transition Efforts to Support Wx/Cx Extremes R2O	Dan Barrie
9:40 am	CPC Extended Range and Hazard Outlooks	Matt Rosencrans
10:00 am	Climate Based Issues/Tools and the NOAA Hurricane Outlook	Gerry Bell
10:30 am	BREAK	
Session 2	Science Updates Extended Range	
11:00 am	CFS Ensembles and Severe Weather	Greg Carbin
11:20 am	Assessment of CFS Predictions of U.S. Severe Weather Activity	Mike Tippett
11:40 am	MJO and Variability of Spring-Season Severe-Day Frequency	Brad Barrett
12:00 pm	The Global Wind Oscillation and U.S. Tornadoes	Victor Gensini
12:20 pm	LUNCH	
Session 3	Science Updates Long Range	
1:20 pm	New Methods in Tornado Climatology	James Elsner
1:40 pm	ENSO Phase Evolution and the Relationship to Tornado Outbreaks	Sang-Ki Lee
2:00 pm	ENSO and Seasonal Severe Weather Predictability	John Allen
2:20 pm	Impact of ENSO on Late Winter/Early Spring Tornado Outbreaks	Ashton Robinson
2:40 pm	BREAK	
Session 4	Regional Applications	
3:00 pm	Simulation of North American Low-level Jet Variability in CFS	Scott Weaver
3:20 pm	On the Significance of Multiple Consecutive Days of Tornado Activity	Jeff Trapp
3:40 pm	Optimal Physics Ensemble to Improve Extreme Event prediction	Xin-Zhong Liang
4:00 pm	CFS Forecast Evaluation	Adam Stepanek
4:20 pm	Charge for Day 2 and Adjourn	

Questions For Consideration

- What exactly are we trying to forecast in our proposed outlooks? In other words what is our definition of severe weather? Tornadoes grab the headlines but other forms of severe weather are potentially just as damaging and possibly “easier” to predict. Should this be a DMC outlook?
- How can we start to think about transitioning some of the basic research to applications, adding to the existing applied scientific tools for these outlooks?
- What are the best approaches in marketing our efforts to gain further research support? Can we leverage our results toward other current high priority efforts? i.e., NMME, downscaling programs, parameterization efforts, observationally based programs, private sector, etc.
- What should the operational outlook process look like? There are basically 2 lines of attack in the research community, intraseasonal and seasonal. Both have received queries and support from the Whitehouse. How will the NCEP/SPC and NCEP/CPC work together with outside partners to leverage expertise? Should an experimental testbed be initiated? These partnerships will require a financial commitment of support for research and advisement efforts.